ComEd
An Exelon Company

ComEd Islanding Protection

ComEd's protection philosophies ensure a reliable and safe design for ComEd's system, ComEd's customers, and the connecting distributed resource (DR).

ComEd's basic philosophies on islanding protection are:

- The protection system shall ensure that safety is not compromised.
- The protection system shall ensure that in the event of an electrical island customers do not suffer degraded voltage or frequency. The non-generating customers served from the same line should not experience any degraded service after the DR is added to the line.
- The protection system shall ensure that damage to ComEd equipment will not occur due to the addition of the DR.
- The protection system should be planned to detect only the abnormalities that mandate a separation between the DR and the supply line. Normal plant operation and normal supply line operation should not cause any form of unwanted tripping. For example, switching of capacitor banks, faults on other lines, sudden losses of customer load, and automatic load tap changing should not cause interface protective devices to operate.
- The connection and protection applied should not lessen or complicate the ability of the operating dispatcher or line crews to quickly respond to system events or in general to run the system.
- The interface protection should be appropriately balanced between risk minimization and installation cost. For example, a requirement that the interface transformer be changed to a wye connected high-side for every distributed resource project would be too costly yet it would eliminate overvoltage issues on 12kV distribution circuits.

Most of ComEd's customers that wish to install parallel generation are already connected to ComEd. The typical connection of a customer to a distribution circuit is via a delta high-side, wye low-side connected transformer. Delta connections pose no system hazard if they just supply radial load. They provide the benefit of minimizing voltage fluctuations and harmonics to some extent on the customer side of the transformer for disturbances on the high side of the transformer. ComEd has converted wye-wye connected customers with power quality problems to delta-wye and alleviated many customer issues. The protection philosophy ComEd has chosen does not require a change-out of this type of transformer in order to protect the system.

ComEd uses a series of protection modifications depending on the ability of a distributed resource to island a circuit section. The size of a distributed resource is compared to the minimum line or circuit section load to determine the probability of a DR's ability to island a circuit section. Fractions of the minimum line or circuit section load are used for many reasons. First, generation can often carry multiples of their nameplate capacity in an islanded mode. Second, an exact line or circuit section load is a moving target that can

change at any time due to circumstances beyond the utility's control. Circuits out of standard configuration due to storms, system emergencies, maintenance, or etc. may have minimum loads much lower than normal. Customers with equipment out of service may have minimum loads much lower than normal. Since it is not practical to keep track of changes in minimum load or return to already-connected DR customers for upgrades if a circuit's minimum load decreases, consideration of these contingencies is warranted.

Islanding of faulted feeders occurs whenever utility protection is faster than the protection at the DR. This is generally the case since installation of very fast tripping at DR installations increases the likelihood of unwanted false DR trips. Islanding of un-faulted feeders can occur due to an inadvertent opening of a circuit by a utility operator, by an opening of a utility feeder circuit breaker due to a fault external to the feeder (i.e. a source station bus fault), or by equipment malfunction at the DR site.

Induction generators can island feeders if sufficient capacitance is present. A typical ComEd 12kV feeder has at least one and as many as 3 or 4-1.2 MVAR banks of capacitance to provide system voltage support. These capacitances are in most cases in service for most of the day year round. An induction DR installation may contain a sufficient amount of its own capacitance for power factor correction. For instance, many wind generators come with a significant amount of power factor correction capacitance built in. An induction generator can be self-excited by capacitance equivalent to 30% of the nameplate rating. Practically speaking there is generally enough capacitance on ComEd circuits to self-excite even the largest generators that may be connected to distribution circuits. Thus, islanding and protection considerations for induction generators are similar to synchronous generators.

If a distributed resource is connected to the wye-connected secondary of a delta high-side transformer (the typical connection), islanding conditions can have severe consequences. Perfect balance of feeder loads is rarely achieved. Least cost planning dictates that circuit loads are balanced only when a given phase of a feeder is overloaded. Operation of single-phase devices can also cause circuit imbalances. Circuits that are not perfectly balanced experience unbalanced voltages when fed from an ungrounded source. Lightly loaded circuits fed from an ungrounded source can experience ferroresonance when fed from an ungrounded source. Ferroresonance can cause voltages as high as 3.0 per unit. Unbalanced or high voltages can cause damage or degraded life to both ComEd equipment and customer equipment.

Although rare, ComEd has had actual islanding occurrences by generators of at least a Plan B size. These occurrences have shown that depending on the circuit, islanding may cause damage to ComEd or customer equipment or cause little or no damage.

ComEd's Plan A covers generators with little chance of islanding. At these installations, ComEd relies on local voltage and frequency relays for islanding protection at the DR interface. These relays are set to trip for islanding conditions and to be able to ride through system disturbances that do not require a DR trip. For these smaller installations, this protection also provides disconnection of the DR for fault conditions on the ComEd feeder. It is unlikely that a single Plan A size generator will be able to sustain voltage on a feeder after the utility source is disconnected. Changes at the ComEd substation are extremely rare for these installations.

ComEd's Plan B covers generators with a good chance of islanding. ComEd relies on local voltage and frequency for islanding protection at the DR interface. In addition, ComEd adds a requirement to sense a dead line prior to reclosing into a feeder and to check for synchronism prior to manually closing into a feeder with a good chance of islanding. Sensing a dead line prior to reclosing assures that a DR is disconnected prior to ComEd re-livening its' circuit. Attempting to reclose into lines still alive with voltage from generators will be unsuccessful and degrade reliability to load customers. Experiences at other utilities have shown that closing into generators prior to disconnecting will damage them. ComEd has not had these experiences. The same relays that provide reclosing supervision provide synch check. This is used to ensure that operating personnel can perform switching seamlessly and out of phase closing into a DR will not occur. Out of phase closing into a DR could damage the DR or ComEd equipment.

ComEd's Plan C covers generators that are very likely to be able to island a feeder. Requirements are the same as Plan B with the addition of transfer tripping from the ComEd source. Transfer tripping allows for a near simultaneous disconnection of the DR and the ComEd source and avoids any of the negative affects of even a short period of islanding of a large DR. In addition to islanding protection, it also provides high speed tripping for feeder faults and limits the amount of damage to ComEd equipment due to fault currents generated by the connected DR.

ComEd does not recommend reverse power relaying as islanding protection for any of its DR Plans. Furthermore, reverse power relaying does not provide the benefits of dead line sensing of reclosing or transfer tripping.

- Dead line sensing assures that ComEd will not cause any damage to customer generators or to ComEd equipment due to feeder reclosing even when the DR trips slow or fails to trip. No damage to customer's generators assures good availability of customer generators, minimizes operational costs, and maximizes the benefits of DR to customer and the system.
- Dead line sensing also assures that the DR is disconnected and the fault arc is extinguished prior to reclosing. This ensures successful recloses and high customer reliability for transient faults. Standard feeder reclosing provides quick restoration of power for transient faults and time coordinates with other feeder devices such as automatic transfer switches used to increase reliability to load customers.

It should be noted that the requirement for dead line sensing is not unique to ComEd. According to PG&E's white paper, <u>General Technical Requirements for DG Interconnections (8-11-04):</u>

"Reclose Blocking is needed on any PG&E automatic reclosing devices upstream of the generator if the aggregate nameplate capacity of the generation exceeds 15% of the peak load on that automatic reclosing device. Automatic reclosing devices on the PG&E distribution system are limited to line reclosers and feeder breakers. The purpose of reclose blocking is to reduce the safety risks to the customer, the public, and PG&E employees which could result from the synchronous machine closing into out-of-phase conditions."

In New York, dead-line sensing may be required by the utilities depending on system conditions (line load, generator capacity, etc.). For example, at the Long Island Power Authority, the Long Island Power Authority Interconnection Requirements For New Distributed Generation Greater Than 300 kVA Operating In Parallel With LIPA's Radial Distribution System (Revised and Issued March 2003) states in Section IV-25:

"The LIPA substation feeder breaker may require a set (3) of line side potential transformers to monitor the presence of voltage on the distribution feeder and to provide voltage to a synch check or voltage relay, which shall prevent closing the breaker into an unsynchronized DG System's generator. All costs incurred to purchase and place this system in service shall be at the DG System's expense."

At ConEd, Consolidated Edison's Handbook of General Requirements For Electrical Service To Dispersed Generation Customers (Specification EO-2115, Revision 4 dated December 2000) states in Section III – 2.5 (pps.25-26) states in part:

"In addition, depending on the rating of the generator and the magnitude of the load that it may become isolated with, it may be necessary to install dead-line sensing and/or direct transfer trip equipment between the Company supply feeder breaker and the intertie breaker. Dead-line sensing relays block reclosing if voltage is sensed on the generator side of the Company's recloser breaker. If the load that could become isolated with the generator is smaller than the generator capacity, it may be necessary to require direct transfer trip to avoid the possibility of the generator producing damaging over-voltages during these conditions."

- Line sensing and modern relaying at the line source provides ComEd with detailed oscillographic information on what is happening to its circuit during disturbances.
- Transfer trip, applied to the largest DRs, limits the amount of damage to ComEd's system due to islanding or DR fault contributions by assuring very quick tripping.

Additionally, ComEd's experience with customers using reverse power relays has shown that excessive operations will occur. The approach was abandoned by customers and subsequently not recommended by ComEd because of the large number of unacceptable false trips experienced by customers due to transient power swings.

Attempts to vary the reverse power relay settings were not effective in reducing the number of false customer DR trips to a level acceptable to the customers.

ComEd's requirements for islanding protection provide a balanced fair approach that protects both the system and the DR from the negative affects of DR islanding.

Prepared by ComEd Protection Services
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